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LAKE MEAD G-E-M
RESOURCES AREA
(GRA NO. NV-35)
TECHNICAL REPORT

(WSAs NV 050-0231, 050-0233, 050-0235, 050-0236, and 050-0238)

Contract YA-553-RFP2-1054

Prepared By

Great Basin GEM Joint Venture
251 Ralston Street
Reno, Nevada 89503

For

Bureau of Land Management
Denver Service Center
Building 50, Mailroom
Denver Federal Center
Denver, Colorado 80225

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EXECUTIVE SUMMARY

The Lake Mead Geology-Energy-Minerals (GEM) Resource Area (GRA) is 20 miles southeast of Overton in Clark County, Nevada. The GRA covers most of the peninsula lying between the main body of Lake Mead and Overton Arm. There are five Wilderness Study Areas (WSAs): NV 050-0231, 050-0233, 050-0235, 050-0236, and 050-0238.

The southern half of the GRA is underlain by rocks intensely metamorphosed that are probably about one billion years old, while much of the northern half is underlain by sediments 200 million to 600 million years old. Sediments and a small area of volcanic rocks, both about 10 million years old, cover part of the GRA. There are numerous faults, one of which may displace the rocks by as much as ten miles and which separates the billion-year-old rocks from those only hundreds of millions of years old.

The Gold Butte mining district is in the middle of the GRA, with old mines and prospects scattered rather widely throughout the GRA. One mine has produced somewhat less than $100,000 in gold (less than $1 million at 1982 prices), and there are small mines or occurrences of copper, lead, tungsten, titanium and uranium. Small quantities of mica and vermiculite have been produced, and there are large deposits of limestone and dolomite that have not been mined. There may be gypsum deposits.

Much of WSA NV 050-0231 has patented mining claims, but there are no others in the GRA. There are a great many unpatented claims, most of which are clustered in the center of the GRA, away from the WSAs. There are unpatented claims in a small portion of WSA NV 050-0233, and unpatented claims that were probably located for uranium in two areas of WSA NV 050-0238. There are a great many oil and gas leases, and most of the WSAs are covered by leases. There are no sodium and potassium or geothermal leases, and no material sites are known in the WSAs.

WSA NV 050-0231 is classified as having very low favorability, with low confidence for metallic minerals in its entirety. Most of it is classified as moderately favorable for uranium and thorium with moderate confidence, but the southwestern part is classified as having low favorability with low confidence. Most of the WSA is moderately favorable for limestone and dolomite with moderate confidence, a small part is moderately favorable for gypsum with low confidence, and the western part is moderately favorable for sand and gravel with moderate confidence. All of the WSA is classified as having low favorability for oil and gas and for geothermal resources with low confidence.

WSA NV 050-0233 has a small area moderately favorable for metallic minerals with low confidence, but most of it is classified as having very low favorability with low confidence. For uranium and thorium about half of it has moderate favorability with moderate confidence, and the remainder has low favorability with low

confidence. Most of the WSA has moderate favorability for limestone and dolomite with high confidence, and the remainder has moderate favorability for sand and gravel with moderate confidence. Oil and gas and geothermal are both classified as having low favorability with very low confidence.

WSA NV 050-0235 is all classified as having very low favorability for metallic minerals with very low confidence. About half of it has moderate favorability with moderate confidence for uranium and thorium and the remainder has low favorability with low confidence. About half of it has low favorability with low confidence for nonmetallic minerals but the other half has moderate favorability with moderate confidence for sand and gravel. Oil and gas is classified as having low favorability with low confidence. About half of the WSA has low favorability for geothermal resources with very low confidence, while the other half has very low favorability with very low confidence.

WSA NV 050-0236 all has very low favorability for metallic minerals with very low confidence. Most of it has very low favorability with very low confidence for nonmetallic minerals, but a small strip has moderate favorability with moderate confidence for titanium. It is all classified moderately favorable with moderate confidence for uranium and thorium. The entire WSA has low favorability with very low confidence for oil and gas and very low favorability with very low confidence for geothermal resources.

WSA NV 050-0238 has very low favorability with very low confidence for metallic minerals and for uranium and thorium. Most of it has low favorability with low confidence for nonmetallic minerals but a narrow strip has moderate favorability with moderate confidence for titanium. The entire WSA has low favorability with very low confidence for oil and gas and very low favorability with very low confidence for geothermal.

Checking of BLM plats for patented claims in WSA NV 050-0231 is recommended. Checking of unpatented claim records in WSAs NV 050-0233 and 050-0238, and possible subsequent field checking is recommended.

I. INTRODUCTION

The Lake Mead G-E-M Resources Area (GRA No. NV-35) contains approximately 330,000 acres (1,400 sq km) and includes the following Wilderness Study Areas (WSA):

WSA Name	WSA Number
Lime Canyon	NV 050-0231
Milton Hills	NV 050-0233
Carrott Buttes	NV 050-0235
Jumbo Springs	NV 050-0236
Bonelli Peak	NV 050-0238

The GRA is located in Nevada/Arizona in the Bureau of Land Management's (BLM) Caliente Resource Area, Las Vegas district. Figure 1 is an index map showing the location of the GRA. The area encompassed is near 36°20' north latitude, 114°15' west longitude and includes the following townships:

Nevada Townships	Arizona Townships
T 17 S, R 68-70 E	T 33 N, R 16 W
T 18 S, R 68-71 E	T 34 N, R 17 W
T 19 S, R 68-71 E	
T 20 S, R 68-71 E	
T 21 S, R 68-71 E	
T 22 S, R 69,70 E	

The areas of the WSAs are on the following U. S. Geological Survey topographic maps:

15-minute:

Overton Beach
Virgin Basin
Gold Butte
Iceburg Canyon

The nearest town is Overton which is located about six miles northwest of the northwest corner of the GRA along State Route 12. Access to the area is via New Gold Butte Road to the north, Grand Gulch Road to the east, and State Route 12 to the west (then boat across Lake Mead). Access within the area is via unimproved dirt roads such as Scanlon Ferry Road and via jeep trails.

Figure 2 outlines the boundaries of the GRA and the WSAs on a topographic base at a scale of 1:250,000.

Figure 3 is a geologic map of the GRA and vicinity, also at 1:250,000. At the end of the report, following the Land Classification Maps, is a geologic time scale showing the various geologic eras, periods and epochs by name as they are used in the text, with the corresponding age in years. This is so that the reader who is not familiar with geologic time subdivisions will have a comprehensive reference for the geochronology of events.

This GRA is one of fifty-five reports on the Geology-Energy-Minerals potential of Wilderness Study Areas in the Basin and Range Province, prepared for the Bureau of Land Management by the Great Basin GEM Joint Venture.

The principals of the Venture are Arthur Baker III, G. Martin Booth III, and Dennis P. Bryan. The study is principally a literature search supplemented by information provided by claim owners, other individuals with knowledge of some areas, and both specific and general experience of the authors. Brief field verification work was conducted on approximately 25 percent of the WSAs covered by the study.

None of the WSAs in this GRA were field checked.

One original copy of background data specifically applicable to this GEM Resource Area Report has been provided to the BLM as the GRA File. In the GRA File are items such as letters from or notes on telephone conversations with claim owners in the GRA or the WSA, plots of areas of Land Classification for Mineral Resources on maps at larger scale than those that accompany this report if such were made, original compilations of mining claim distribution, any copies of journal articles or other documents that were acquired during the research, and other notes as are deemed applicable by the authors.

As a part of the contract that resulted in this report, a background document was also written: Geological Environments of Energy and Mineral Resources. A copy of this document is included in the GRA File to this GRA report. There are some geological environments that are known to be favorable for certain kinds of mineral deposits, while other environments are known to be much less favorable. In many instances conclusions as to the favorbility of areas for the accumulation of mineral resources, drawn in these GRA Reports, have been influenced by the geology of the areas, regardless of whether occurrences of valuable minerals are known to be present. This document is provided to give the reader some understanding of at least the most important aspects of geological environments that were in the minds of the authors when they wrote these reports.

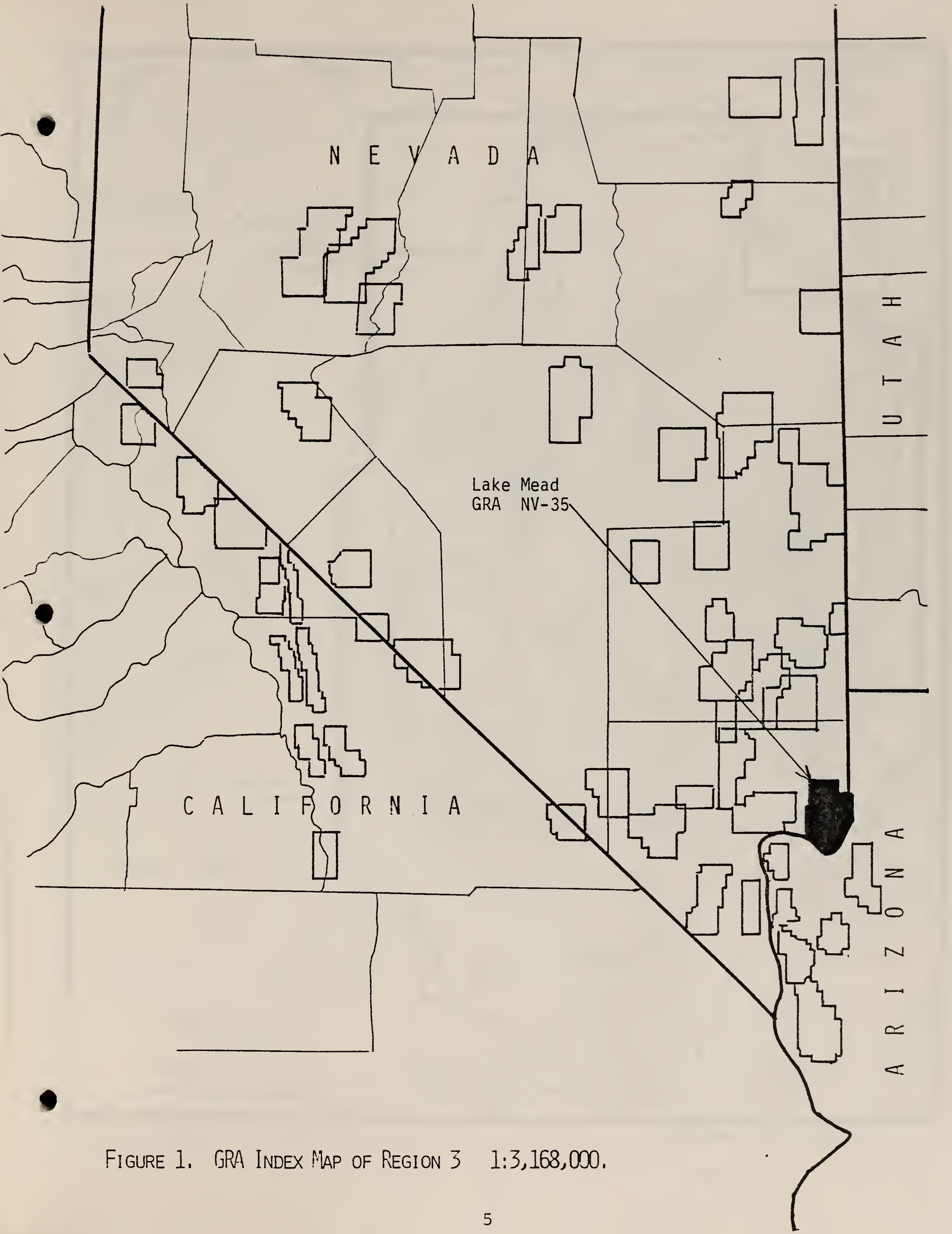
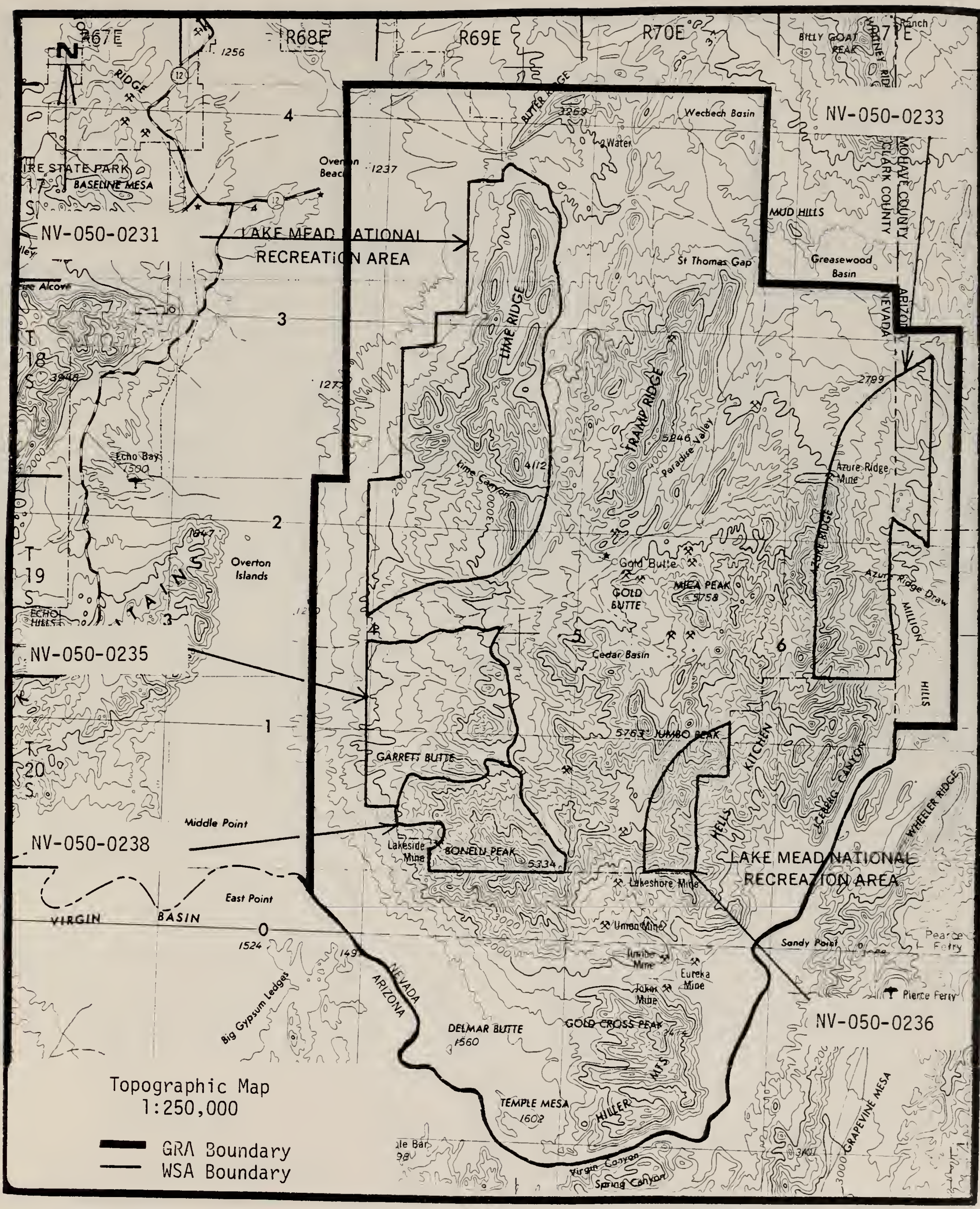


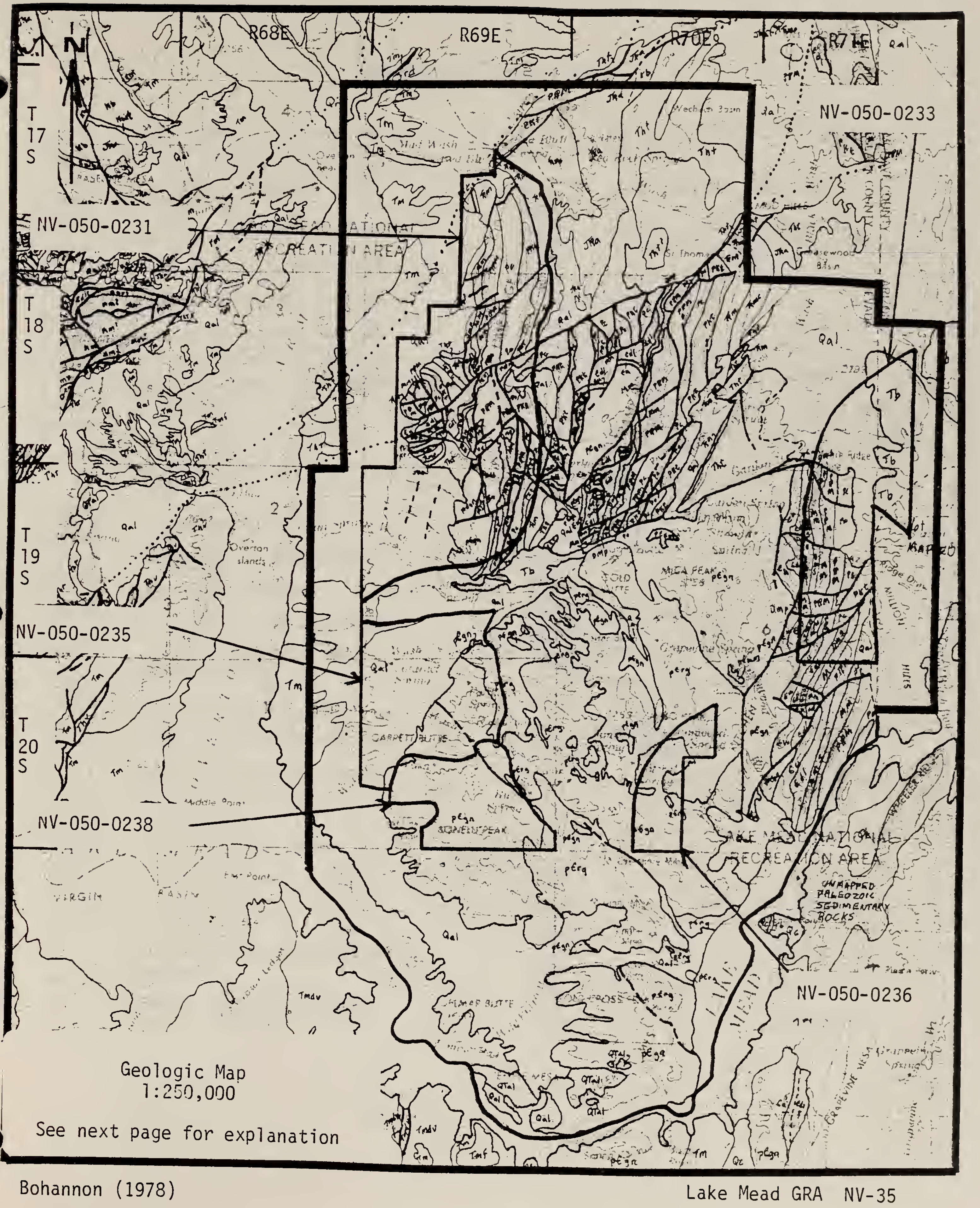
Figure 1. GRA Index Map of Region 3 1:3,168,000.



Las Vegas Sheet

Lake Mead GRA NV-35

Figure 2



Geologic Map
1:250,000

See next page for explanation

Bohannon (1978)

Lake Mead GRA NV-35

Figure 3

DESCRIPTION OF MAP UNITS

Qal	ALLUVIAL DEPOSITS (HOLOCENE AND PLEISTOCENE?)
Qp	PLAYA DEPOSITS (HOLOCENE AND PLEISTOCENE?)
Qc	CHEMEHUEVI FORMATION (PLEISTOCENE)
Ql	LAS VEGAS FORMATION (PLEISTOCENE)
Qm	CALICHE OF MORMON MESA (PLEISTOCENE)
Qrc	GRAVEL OF THE COLORADO AND VIRGIN RIVERS (LOWER PLEISTOCENE)
QTal	ALLUVIAL FAN DEPOSITS (QUATERNARY AND TERTIARY)
Tb	BASALT (PLIOCENE AND MIOCENE)
	MUDDY CREEK FORMATION (PLIOCENE? AND MIOCENE)
Tm	Claystone unit
Tmf	Fortification Basalt Member
Tpw	ASH-FLOW TUFF (MIOCENE)
Tp	ROCKS OF PAVITS SPRINGS (MIOCENE)
Thv	ROCKS OF THE HAMBLIN-CLEOPATRA VOLCANO (MIOCENE)
Thvi	INTRUSIVE ROCKS (MIOCENE)
Tmdv	MOUNT DAVIS VOLCANICS (MIOCENE)
	HORSE SPRING FORMATION (MIOCENE)
Ths	Sandstone and silver tuff
Thl	Rocks of Lovell Wash
Thb	Limestone of Bitter Ridge
Tht	Lower member
Tsu	UNDIFFERENTIATED SEDIMENTARY ROCKS (TERTIARY)
Kb	BASELINE SANDSTONE (UPPER AND LOWER CRETACEOUS)
Kwt	WILLOW TANK FORMATION (LOWER CRETACEOUS)
Ja	AZTEC SANDSTONE (JURASSIC)
Ŧmc	MOENAVE (UPPER TRIASSIC?) AND CHINLE (UPPER TRIASSIC) FORMATIONS
Ŧm	MOENKOPI FORMATION (MIDDLE? AND LOWER TRIASSIC)
Pkt	KAIBAB LIMESTONE AND TOROWEAP FORMATION (LOWER PERMIAN)
Pc	CLASTIC ROCKS (LOWER PERMIAN)
PPM	CALLVILLE LIMESTONE AND BIRD SPRING FORMATION (LOWER PERMIAN, PENNSYLVANIAN AND UPPER MISSISSIPPIAN)
Mm	MISSISSIPPIAN ROCKS
	DEVONIAN ROCKS
Dmp	Muddy Peak Limestone
Dms	Sultan Limestone
Sl	SILURIAN ROCKS
Ou	ORDOVICIAN ROCKS
OCu	UNDIFFERENTIATED ORDOVICIAN AND CAMBRIAN ROCKS
Cdl	CARBONATE ROCKS (UPPER AND MIDDLE CAMBRIAN)
Cu	UNDIFFERENTIATED CLASTIC ROCKS (MIDDLE AND LOWER CAMBRIAN)
C-Du	UNDIFFERENTIATED DEVONIAN THROUGH CAMBRIAN ROCKS
Pzu	UNDIFFERENTIATED PALEOZOIC ROCKS
pCsj	STIRLING QUARTZITE AND JOHNNIE FORMATION (PRECAMBRIAN)
pCum	ULTRAMAFIC ROCKS (PRECAMBRIAN)
pCgs	GNEISS AND SCHIST (PRECAMBRIAN)
pCrg	RAPAKIVI GRANITE (PRECAMBRIAN)

——— CONTACT

——— FAULT

⊥⊥⊥ THRUST FAULT

⊥⊥⊥ LOW-ANGLE FAULT

┼ ANTICLINE

┼ SYNCLINE

II. GEOLOGY

The Lake Mead GRA lies in the Basin and Range Province of east-central Clark County, Nevada. The study area is a peninsula extending into by Lake Mead.

The GRA contains the north-south-trending South Virgin Mountains, a series of complex fault blocks composed of Precambrian gneiss and schist in the south and predominantly Paleozoic through Tertiary sediments in the north.

Faulting in the study area is complex and is predominantly in the Paleozoic through Tertiary sediments. The large exposed mass of Precambrian granitic-metamorphic rocks in the southern portion of the study area is little affected by faulting and only locally contains short extensions of faults from the adjacent sediments.

1. PHYSIOGRAPHY

The Lake Mead GRA lies within the Basin and Range Province in east-central Clark County, Nevada. The study area is a peninsula bounded on the south and east by Lake Mead which lies along the Arizona-Nevada state border line and on the west by the Overton Arm of Lake Mead.

The topography is rugged with elevations averaging about 4,000 feet along the ridges in the northern half of the study area. The highly dissected Precambrian granitic-metamorphic terrane in the south has several peaks with elevations over 5,000 feet. The entire area drains into Lake Mead which has an elevation of about 1,300 feet.

2. ROCK UNITS

The oldest rocks in the study area are Precambrian gneiss and schist which have been intruded by the Precambrian Gold Butte granite. A large mass of Precambrian rocks crops out south of the Gold Butte fault. Smaller fault blocks of Precambrian rocks also occur southwest and east of Lime Ridge. Paleozoic through late Tertiary sediments and Tertiary volcanics crop out predominantly in the northern half of the study area along north trending ridges. Paleozoic sediments also crop out along Azure Ridge on the eastern flank of the Precambrian mass in the southern portion of the study area.

Unconformably overlying the Precambrian rocks are Lower and Middle Cambrian undivided quartzite, shale and limestone which are conformably overlain by Upper Cambrian unnamed dolomite and limestone.

The next youngest formation is the Devonian Muddy Peak Limestone which is overlain by the Mississippian Rogers Spring Limestone. Deposited next was the pink to bright red sandstone of the Pennsylvanian(?) Supai Formation which is overlain by the Permian Kaibab limestone (Longwell, and others, 1965).

The Moenkopi Formation, unconformably overlying the Kaibab limestone, was deposited next. It consists of limestone, shale, sandstone and gypsum. Unconformably overlying the Moenkipi Formation is the upper Triassic Chinle Formation which has a clastic sequence of sandstone, shale, gypsum, and some silicified wood. The thick and widespread Jurassic Aztec sandstone is the next youngest formation. Eocene(?) conglomerate, gypsum and other chemical precipitates were deposited next, as the Horse Spring Formation.

A sequence of undifferentiated silicic volcanic rocks related to Tertiary tectonic events crop out along the Gold Butte fault.

During the Pliocene, intermontane clays, silt, sand and saline deposits of the Muddy Creek Formation were deposited unconformably over the Horse Spring Formation and older sediments. The Muddy Creek Formation crops out in isolated patches surrounded by recent alluvium in the valleys and along the shore of the Overton Arm of Lake Mead.

3. STRUCTURAL GEOLOGY AND TECTONICS

Faulting in the Lake Mead GRA is complex and is recognized predominantly in the Paleozoic through Tertiary sediments. The large exposed mass of Precambrian granitic-metamorphic rocks in the southern portion of the study area displays little faulting and only locally contains short extensions of faults in the adjacent sediments (Longwell and others, 1965).

Two prominent sets of mid-Tertiary Basin and Range-type normal faults transect the post-Precambrian sediments. One set trending north-south has formed Lime and Tramp Ridges south of St. Thomas Gap. Eastward tilting and duplication of formations by the faulting have made these ridges structural composites.

These ridges have been offset by a secondary set of faults trending about N 60° E. The Gold Butte fault separates the Precambrian granitic-metamorphic complex in the south from Lime and Tramp Ridges. The throw of this fault is estimated to be about 12,000 feet. The Lime Ridge fault, parallel to the Gold Butte fault, forms the northern termination of Tramp Ridge and continues across Lime Ridge to the western border of the range. Displacement at the north end of Tramp Ridge is about 2,000 feet, with an increase in movement to the southwest (Longwell, 1928). Northeast-trending faults appear

to be dominant in Azure Ridge on the northeast side of the Precambrian mass.

The close similarity of Lime Ridge to Tramp and Azure Ridges may suggest that strike-slip movement occurred along the northeast trending Lime Ridge and Gold Butte faults.

A small remnant of a thrust sheet crops out along Bitter Ridge in the northwest corner of the GRA. The overriding plate of Permian Kaibab limestone rests on a lower plate of Jurassic Aztec sandstone, a situation which is similar to the Muddy Mountain thrust to the west (Longwell, 1952).

4. PALEONTOLOGY

Pennsylvanian-Permian carbonates of the Callville Limestone contain fossil brachiopods, crinoids, corals, and mollusks in the northwestern part of the GRA along the west flank of Lime Ridge. Rocks of the Monte Cristo (Mississippian) are sparsely fossiliferous in about the same area.

Siltstones and clays of the Chinlee Formation (Late Triassic) are devoid of fossils in this area. The Horse Spring elsewhere contains mammals, and is exposed over wide areas of the central part of the GRA, south of Tramp Ridge. No localities are known from this area, but it is an area of high potential for fossils.

5. HISTORICAL GEOLOGY

During the Precambrian, existing sedimentary and igneous rocks were intruded by later Precambrian granitic plutons.

Clastic Cambrian sediments were deposited on an erosion surface developed during a period of peneplanation in early Cambrian time. Paleozoic marine sediments of both carbonate and clastic facies were deposited indicating an oscillation between shallow sea and deltaic depositional environment.

A period of uplift and erosion followed the Paleozoic. During the Jurassic, a great desert covered the region and the extensive Aztec sandstone was deposited at this time. Due to the absence of Mesozoic sediments younger than the Aztec sandstone, details of Mesozoic history later than the lower Jurassic are not revealed (Longwell and others, 1965).

Overthrusting and folding related to the Laramide orogeny began sometime during the Cretaceous. Basin and Range normal faulting may have begun in mid-Tertiary times, and have been reactivated during the Pliocene as evidenced by the deformation of Pliocene intermontane clays of the Muddy Creek Formation.

Volcanism produced local silicic flows during the early Tertiary. Contemporaneously, shallow lake chemical precipitates were deposited in some basins. A period of erosion followed as evidenced by the angular unconformity between the Horse Spring and Muddy Creek Formations.

The Muddy Creek Formation, deposited during the Pliocene, is similar to the Horse Spring Formation, but contains a finer sized clastic sequence and beds of clay. As mentioned above, these clays have been locally deformed indicating that Pliocene age Basin and Range type faulting remained active or was reactivated during the Pliocene.

III. ENERGY AND MINERAL RESOURCES

A. METALLIC MINERAL RESOURCES

1. Known Mineral Deposits

The Gold Butte district lies in the middle of the GRA, extending from near the south boundary to near the north boundary -- an areally large district with rather widely scattered mines and prospects and a diverse suite of metals and nonmetallic minerals. None of the mines have been large; recorded production for most of them is only a few tons of ore. Metals produced or occurring are gold, silver, copper, lead, zinc, tungsten and beryllium. Uranium and nonmetallic minerals also have been produced or occur in the district, and these will be treated in the appropriate sections.

Apparently on the western boundary of WSA NV 050-0233 is the Azure Ridge mine (#1 on the Metallic Minerals Occurrence and Land Classification Map), with reported production of a couple of carloads of high-grade zinc ore and one carload of high-grade copper ore.

Half a mile from the western boundary of WSA NV 050-0236 is the Lakeshore mine (#2), credited with about $100,000 production in gold. A couple of miles to the north and about the same distance from the WSA is the Windmill prospect (#3), which has gold and silver occurrences.

In a small reentrant of the western boundary of WSA NV 050-0238 is the Lakeview mine (also known as Lakeside) (#4), which produced a small amount of gold, silver and copper in the mid-1950s. All of the above data is from Longwell and others (1965).

2. Known Prospects, Mineral Occurrences and Mineralized Areas

MILS data plot shows the Whitmore gold prospect in the eastern tip of WSA NV 050-0238. The property description, however, places it two miles east of the plotted position, outside the WSA and close to other known gold mines and prospects. We conclude the latter location is most likely to be correct.

There are no known metallic mineral prospects, occurrences or mineralized areas within the WSAs.

Beryllium is reported at one site near the middle of the GRA.

3. Mining Claims

There are patented claims in 16 sections in WSA NV 050-0231. The distribution of some of these (on Lime Ridge in the northern part of the WSA) suggests that several adjacent sections may be entirely patented, perhaps for limestone. There are no other patented claims in the GRA.

There are a great many unpatented claims in the GRA, mostly concentrated in the central part around Gold Butte and Mica Peak, not in or near WSAs.

In WSA NV 050-0233 several unpatented claims east of the Azure Ridge mine (#1) are within the WSA.

In WSA NV 050-0238 there are unpatented claims north and east of the Lakeview (Lakeside) mine (#4) in the western part of the WSA. There is also a cluster in one section in the southeastern tip of the WSA. All of these were recorded by Nuclear Power and Energy Corp., a name which suggests that they were located for uranium.

4. Mineral Deposit Types

In the northern part of the GRA the mineral deposits are pockety replacements in the Paleozoic carbonate sediments; the Azure Ridge mine is one such deposit. All of them are principally copper or copper-zinc occurrences and all are small (Longwell and others, 1965). In the southern part of the GRA the Paleozoic sediments are not present and the terrane is exclusively Precambrian schists, gneisses and granites. Here the metallic deposits are quartz veins that have been mined and prospected principally for gold or gold-silver values, but there are some base metals associated with them. Locally there are tungsten occurrences. The largest of the vein mines was the Lakeview (Longwell and others, 1965). There are also placer deposits with minor production in the vicinity of Gold Butte. The one reported occurrence of beryllium (Longwell and others, 1965) is probably in a pegmatite.

5. Mineral Economics

All known metallic mineral occurrences in the Lake Mead GRA are small; the largest of the mines produced only $100,000 in gold, worth about $1 million in the 1980s. Deposits of this size are not of interest to major mining companies, but may be of interest to individuals or small, local organizations.

There is some possibility that the small replacement bodies in carbonate rocks in the northern part of the GRA might indicate the presence of larger bodies somewhere in

the area. Probably the area will be prospected from time to time by major companies looking into this possibility.

The major use of gold is for storing wealth. It is no longer used for coinage because of monetary problems, but many gold "coins" are struck each year for sale simply as known quantities of gold that the buyer can keep or dispose of relatively easily. The greatest other use of gold is in jewelry, another form of stored wealth. In recent years industrial applications have become increasingly important, especially as a conductor in electronic instrumentation. In the United States and some other countries gold is measured in troy ounces that weigh 31.1 grams -- twelve of which make one troy pound. Annual world production is about 40 million ounces per year, of which the United States produces somewhat more than one million ounces, less than one-fourth of its consumption, while the Republic of South Africa is by far the largest producer at more than 20 million ounces per year. World production is expected to increase through the 1980s. For many years the price was fixed by the United States at $35 per ounce, but after deregulation the price rose to a high of more than $800 per ounce and then dropped to the neighborhood of $400 per ounce. At the end of 1982 the price was $460.50 per ounce.

The major uses of silver are in photographic film, sterlingware, and increasingly in electrical contacts and conductors. It is also widely used for storage of wealth in the form of jewelry, "coins" or bullion. Like gold it is commonly measured in troy ounces, which weigh 31.1 grams, twelve of which make one troy pound. World production is about 350 million ounces per year, of which the United States produces about one-tenth, while it uses more than one-third of world production. About two-thirds of all silver is produced as a by-product in the mining of other metals, so the supply cannot readily adjust to demand. It is a strategic metal. Demand is expected to increase in the next decades because of growing industrial use. At the end of 1982 the price of silver was $11.70 per ounce.

The largest use for copper is in electrical equipment and supplies and in smaller-guage wire where its electrical conductivity is essential. It is also used in large quantities in applications where its corrosion resistance is important -- in housing, brass and bronze, sea-water corrosion resistant alloys and others. It is used also in ammunition, many chemicals, and in applications where its conductivity of heat is important. World production is about 7.5 million metric tons annually, of which the United States produces about 1.5 million tons, nearly sufficient to satisfy domestic demand. Copper is a strategic metal. There are large reserves of copper ore in the world, and the United States has greater reserves

and greater resources than any other country. United States demand is expected to nearly double by the year 2000, but reserves are thought to be sufficient to meet the demand. However, environmental problems of smelting copper may hinder production, and in times of low prices foreign producers tend to maintain full production for political reasons, while domestic producers tend to restrict production for economic reasons. These pressures on the domestic copper industry weaken its competitive capability on the world market. At the end of 1982 the price of copper was 73 cents per pound.

The major uses of zinc are in galvanizing, brass and bronze products, castings, rolled zinc and in pigments or other chemicals. About six million metric tons are produced annually, with the United States producing somewhat less than a quarter of a million tons. Domestic production has decreased dramatically over the past five years, largely as the result of closing down of most zinc smelters because of environmental problems. Imports into the United States are bout one million tons per year, and zinc is listed as a strategic and critical metal. Both world-wide and domestic consumption are expected to increase at a moderate rate over the next twenty years. At the end of 1982 the price of zinc was about 38 cents per pound.

About 80 percent of beryllium is used in alloys, mostly with copper, and most of the alloys are used in electrical applications such as springs, contacts, relays and other equipment. Some is used in aerospace applications, either in alloys or as beryllium metal which has high strength, light weight and excellent anticorrosion characteristics. The United States consumes about 300 tons of beryllium annually, probably more than half of which is produced doemstically. Beryllium consumption is not expected to change greatly by the year 2000, partly because it can be highly toxic especially while being processed, so other materials are used in its stead wherever possible. The mineral beryl, which contains about 11 percent beryllium oxide and is one of the major ores of beryllium, is priced at about $475 per ton, though all sales are negotiated. Some beryl is used as a semi-precious gemstone, and one variety the emerald, is highly prized.

B. NONMETALLIC MINERAL RESOURCES

1. Known Mineral Deposits

Vermiculite deposits two miles east of Gold Butte (#1 on the Nonmetallic Minerals Occurrence and Land Classification Map) produced a few carloads of ore, principally for experimental purposes, and made very little commercial production from a mill that evidently

worked very poorly. However, Leighton's (1967) map shows an area several hundred feet in diameter that contains vermiculite, as well as other smaller areas.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

Most of the Paleozoic rocks which underlie much of WSAs NV 050-0231 and 050-0233 are limestones or dolomites, and elsewhere in the vicinity of Las Vegas are mined for lime. The Triassic Moenkopi Formation, which crops out in a small part of the north end of WSA NV 050-0231, contains gypsum beds which are mined elsewhere in this region.

There are numerous prospects on a variety of other nonmetallic mineral occurrences in the GRA. Among the minerals are magnesite, mica and optical quartz. None of these occurrences are known to be within any of the WSAs of the GRA (Longwell and others, 1965).

Beal (1963) defines two areas of pegmatites (#2, #3), some of which are relatively rich in titanium (as ilmenite and titaniferous magnetite) in the south-central part of the GRA. He comments that there are millions of tons of placer material containing from 2 to 5 percent TiO_2. The edges of these areas lie within the boundaries of WSAs NV 050-0236 and 050-0238.

MILS data plot shows the Tule Springs Pit and Mill producing limestone chips in the south center of WSA NV 050-0231, but the property description puts it in Range 60 E about 60 miles to the west. The plotted site is very remote, with no road access shown on maps. We conclude the plotting is incorrect.

MILS data shows the Lytle Crystals quartz crystals prospect in the northernmost point of WSA NV 050-0236. We assume it lies outside the WSA boundary.

3. Mining Claims, Leases and Material Sites

In WSA 050-0231 the geology and the pattern of patented mining claims suggests a large area that has been patented for limestone, large quantities of which are mined from localities somewhat closer to Las Vegas.

Elsewhere in the GRA, it is impossible to distinguish claims located for nonmetals from those located for metals, except in a few instances -- such as those near known nonmetallic occurrences.

No material sites are known in the WSAs.

In the south end of the GRA within the Lake Mead National Recreation Area, there are mineral leases which, from their locations, probably are for metallic deposits.

4. Mineral Deposit Types

Magnesite and gypsum occur as sedimentary beds within the Tertiary sediments in the northern part of the GRA.

Limestone (and dolomite) are found as beds in the Paleozoic sequence and are most widespread in the northern part of the GRA, but are also present in the eastern edge on Azure Ridge.

The vermiculite deposits occur in Precambrian ultramafic rocks intruded into the Precambrian gneissic terrane in the middle of the GRA. Leighton (1967) does not address the manner in which they were formed, but apparently links their formation with the intrusion of pegmatites into the ultramafics. That they are an alteration product of the ultramafics seems certain.

Mica and titanium (as ilmenite) occur in pegmatites, and titanium also in placers derived from the pegmatites.

5. Mineral Economics

The middle of the GRA is 50 miles or more by road from the nearest rail point at Glendale. Nonmetallic minerals produced in the GRA, then, must have relatively high unit prices to make them worth the long truck haul before they can reach relatively inexpensive rail haulage.

The limestones and dolomites of Lime Ridge may be a special exception to this generalization. They are only two or three miles from Overton Arm of Lake Mead, and by water only ten miles or so from railhead at Overton. It is possible that when easier lime sources are exhausted, their product could be economically barged to Overton.

The low titanium content of pegmatites is not likely to be mined for itself alone, but might be produced as a co-product if the pegmatites contain sufficient other elements or minerals that could be sold. The placer deposits of titanium are large enough to be of potential interest, but similarly large deposits elsewhere are already known and some are in production.

Limestone and dolomite are used principally to produce lime, but some is used as rock for building stone, crushed rock and similar applications. The principal uses of lime are in steel smelting, water purification, as an alkali, in paper and pulp manufacture and sewage treatment. Other

uses for lime are in sugar purification, mortar, and as an agricultural soil conditioner. Limestone with certain clay impurities (called cement rock), or purer limestone with clay added, is used to make cement that is mostly consumed in construction. The United States uses about 20 million tons of lime and 85 million tons of cement annually. For both lime and cement the raw material must be mined within a very few miles of the processing plant, because it has a very low value in the form of run-of-mine rock -- two or three dollars per ton. There are numerous lime and cement plants in the United States, and most of them sell most of their product within a 200 mile radius of the plant. Some cement is imported in the form of clinker, which is the kiln-fired rock that is then ground in the United States. In the early 1980s the price F.O.B. plant of both lime and cement is about $40 per ton.

By far the greatest use of gypsum is in prefabricated products, mostly wallboard, which account for nearly three-fourths of all usage. Most of the remainder is used in cement, as an agricultural soil conditioner, and in plaster. The United States consumes about 20 million tons of gypsum annually, about two-thirds of it produced domestically. Gypsum is a relatively common mineral and occurs in large deposits, and the United States has practically unlimited reserves. However, although its commonness makes it a low-priced material, some plants on the eastern seaboard use imported raw material that can be transported by ship at low cost; these account for the imports of gypsum. United States consumption is forecast to nearly double by the year 2000, with domestic production keeping up with demand except in those special situations where imported material can compete. The price of gypsum is about $7 per short ton.

Vermiculite is a mica-like mineral that has the peculiar property of exfoliating -- expanding greatly by separating on the individual microscopically-thin layers -- when heated. Its principal use is as lightweight aggregate in concrete where acoustic and thermal insulation are desired characteristics. Other uses are as loose-fill insulation in structures, as insulating bedding or covering for molten metal or hot metal ingots and hot chemical pipelines, as an agricultural soil conditioner or plant-growing medium, in water purification and as a filler in paints and plastics. The United States uses about 350,000 tons per year, and produces just about this quantity, although a small tonnage is exported and an equally small tonnage is imported. The United States has half of the world's known vermiculite reserves and the Republic of South Africa has most of the remaining reserves. United States consumption is forecast to about double by the year 2000, with domestic production keeping up with demand. The price of exfoliated vermiculite is about $60 per ton.

Titanium for economic purposes is in two minerals: rutile which is mined only from placer deposits, and ilmenite which is mined from both placer deposits and hard-rock deposits (as a by-product of iron production). The principal use of titanium is as titanium dioxide in paint, paper and plastics where its extreme whiteness is desired; these applications account for more than 90 percent of consumption. Titanium metal is used principally in military aerospace applications, with some usage in the chemical industry, power plants and marine applications. The United States consumes about half a million tons of titanium annually, nearly all of it in the form of the dioxide and only about twenty thousand tons as the metal. Domestic mines produce well under half of that needed to satisfy demand, and titanium is listed as a strategic metal. United States demand for titanium is forecast to about double by the year 2000, while domestic production increases but little. The price of ilmenite is about $50 per ton, while rutile is $200 to $500 per ton. The price for titanium dioxide pigment material is about $1 per pound while titanium sponge metal is about $7 per pound, reflecting the high cost of converting the raw minerals into their usable forms.

C. ENERGY RESOURCES

Uranium and Thorium Resources

1. Known Mineral Deposits

There are two uranium mines within the GRA (see Uranium Land Classification and Mineral Occurrence Map), though outside the WSAs, which have had a minor amount of uranium production. These are the South Valley No. 2 claim and the Hilltop mine. The South Valley No. 2 claim made a shipment of 13 tons of 0.01% uranium oxide and the Hilltop mine produced thirty pounds of samarskite which contained up to 11.3% uranium oxide (Garside, 1973).

There is no record of thorium production from the GRA though thorium is associated with uraniferous minerals in pegmatites within the GRA.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

There are no known uranium or thorium occurrences within the WSAs, though there are uranium and thorium occurrences within the GRA. Both uranium and thorium minerals are found in Precambrian pegmatites in the GRA, and uranium also occurs as secondary mineralization in sedimentary rocks, mainly of the Tertiary Horse Spring Formation (Garside, 1973). The uranium occurrences are indicated on the Uranium Land Classification and Mineral Occurrence Map

included in the back of the report, and tabulated as follows, with thorium also occurring in the pegmatite deposits (Garside, 1973):

Occurrence	Location	Type of Deposit
J. V. property	Sec. 10(?), T 18 S, R 70 E	Not available
Blue Chip Frank Robbin + 4 other prospects	Secs. 13 & 24, T 18 S, R 70 E	Tyuyamunite(?) as coatings in clays of Tertiary Horse Springs Fm.
South Valley No. 2 claim	Sec. 30, T 18 S, R 71 E	Tyuyamunite as coatings in tuffaceous sands of Horse Spring Fm. 13 tons of 0.01% uranium oxide were produced.
First Chance group (20 claims)	Sec. 25, T 18 S, R 70 E	Carnotite or uranophane as disseminations in sandstone of Horse Spring Fm.
Name unknown	Sec. 35(?), T 18 S, R 70 E	Anomalous radioactivity in tuffaceous clay of Horse Spring Fm.
Long Shot No. 1 claim	Sec. 2, T 19 S, R 70 E	Tyuyamunite or uranophane in limey beds of Horse Spring Fm.
Lucky Bart prosp. (8 claims)	Sec. 2, T 19 S, R 70 E	Autunite(?) disseminated in conglomeratic sandstone of Horse Spring Fm.

Horse Spring group, Green Spot group	Sec. 3(?), T 19 S, R 70 E	Carnotite along fractures of Triassic Chinle (?) Fm.
Yellow Queen	Sec. 12, T 19 S, R 69 E	Tyuyamunite(?) as coatings in Tertiary Horse Spring Fm.
Uranium No. 1 prospect, Old Dad prospect	Sec. 32, T 18 S, R 70 E	Monazite, radioactive magnetite, and traces of thorium and uranium in pegmatite cutting Precambrian gneiss
Hilltop mine	Sec. 21, T 19 S, R 70 E	Samarskite and monazite in pegmatite cutting granite. Thirty pounds of samarskite were produced.
Allanite pegmatites	T 19 S, R 70 E	Allanite pegmatites in granite associated with thorium, uranium, and cerium-earth metals.

3. Mining Claims

Unpatented claims in and near WSA NV 050-0238 were recorded by Nuclear Power and Energy Corp., a name which suggests they were located for uranium.

4. Mineral Deposit Types

Uranium and thorium occur as primary minerals in pegmatites associated with a Precambrian granitic intrusion. Samarskite and monazite are the main uranium and thorium minerals found in the pegmatites. Uranium also occurs as secondary mineralization in epigenetic

sandstone-type deposits in the Tertiary Horse Springs Formation. The source of the uranium in these Tertiary sediments is probably the interbedded tuffs of the Horse Springs Formation. The common uranium minerals found in this formation are tyuyamunite, uranophane, carnotite and autunite.

5. Mineral Economics

There are numerous uranium occurrences within the GRA, though none are known within the WSAs. However, much of the WSA areas contain similar geology and should be equally prospective as those areas with known uranium and thorium occurrences. The known occurrences do not represent major ore bodies, and only two deposits have produced a minor amount of uranium.

Sudden drops in the price of uranium and lack of a thorium market have restricted exploration for these radioactive minrals, preventing an economic determination for the area. The small size of the deposits found to date indicate that uranium is only marginally economic within the GRA, and thorium will remain uneconomic for the next several decades. Small-scale mining of thorium from the pegmatite bodies within the GRA is feasible when and if a market for thorium develops.

Uranium in its enriched form is used primarily as fuel for nuclear reactors, with lesser amounts being used in the manufacture of atomic weapons and materials which are used for medical radiation treatments. Annual western world production of uranium concentrates totaled approximately 57,000 tons in 1981, and the United States was responsible for about 30 percent of this total, making the United States the largest single producer of uranium (American Bureau of Metal Statistics, 1982). The United States ranks second behind Australia in uranium resources based on a production cost of $25/pound or less. United States uranium demand is growing at a much slower rate than was forecast in the late 1970s, because the number of new reactors scheduled for construction has declined sharply since the accident at the Three Mile Island Nuclear Plant in March, 1979. Current and future supplies were seen to exceed future demand by a significant margin and spot prices of uranium fell from $40/pound to $25/pound from January, 1980 to January, 1981 (Mining Journal, July 24, 1981). At present the outlook for the United States uranium industry is bleak. Low prices and overproduction in the industry have resulted in the closures of numerous uranium mines and mills and reduced production at properties which have remained in operation. The price of uranium at the end of 1982 was $19.75/pound of concentrate.

Thorium is used in the manufacture of incandescent gas mantles, welding rods, refractories, as fuel for nuclear power reactors and as an alloying agent. The principal source of thorium is monazite which is recovered as a by-product of titanium, zirconium and rare earth recovery from beach sands. Although monazite is produced from Florida beach sands, thorium products are not produced from monazite in the United States. Consequently, thorium products used in the United States come from imports, primarily from France and Canada, and industry and government stocks. Estimated United States consumption of thorium in 1980 was 33 tons, most of which was used in incandescent lamp mantles and refractories (Kirk, 1980b). Use of thorium as nuclear fuel is relatively small at present, because only two commercial thorium-fueled reactors are in operation. Annual United States demand for thorium is projected at 155 tons by 2000 (Kirk, 1980a). Most of this growth is forecast to occur in nuclear power reactor usage, assuming that six to ten thorium-fueled reactors are on line by that time. The United States and the rest of the world are in a favorable position with regard to adequacy of thorium reserves. The United States has reserves estimated at 218,000 tons of ThO_2 in stream and beach placers, veins and carbonatite deposits (Kirk, 1982); and probable cumulative demand in the United States as of 2000 is estimated at only 1,800 tons (Kirk, 1980b). The price of thorium oxide at the end of 1981 was $16.45 per pound.

Oil and Gas Resources

1. Known Oil and Gas Deposits

There are no known oil and gas deposits in the GRA.

2. Known Prospects, Oil and Gas Occurrences and Petroliferous Areas

No or oil seeps have been recorded in the GRA or vicinity, and there have been no oil exploration wells drilled in or in close proximity to the GRA.

3. Oil and Gas Leases

Each of the WSAs have Federal leases covering over half of them.

4. Oil and Gas Deposit Types

Oil deposits that have been found and developed, and those that are being explored for in the Basin and Range to date, have been limited to the Upper Paleozoic section of the miogeosyncline and the Tertiary section of the intermontane basins. The source rocks are assumed to be in Paleozoic horizons, such as the Mississippian Chainman Shale, and perhaps also the Tertiary section.

The reservoirs at the Trap Spring and Eagle Springs oil fields in Railroad Valley are the Oligocene Garrett Ranch volcanics or equivalent, which produce from fracture porosity; or the Eocene Sheep Pass Formation, a freshwater limestone. Minor production has been recorded from the Ely(?) Formation of Pennsylvanian age at Eagle Springs. It may be that production also comes from other units in the Tertiary or Paleozoic sections in the Blackburn oil field in Pine Valley or the Currant and Bacon Flat oil fields in Railroad Valley.

The GRA is within or close to the North American Overthrust Belt which has good oil and gas production in Wyoming/Utah, Mexico and Canada (Oil and Gas Jour., May 12, 1980). The Federal leases in Nevada are for rank wildcat acreage, and surficial stratigraphic units do not necessarily have a direct bearing on possible drilling objectives at depth, considering overthrust structural implications.

Recent seismic surveys (e.g., Seisdata Services, 1981; Geophysical Service Inc., 1981; GeoData, 1981: Index maps in GRA File) indicate, in part, the general area of industry interest. This and certain other data may be purchased, but deep exploratory test data are not readily available. Published maps of the Overthrust Belt in Nevada are very generalized, and are not necessarily in agreement because exploration is at an early stage (Oil and Gas Jour., May 12, 1980; Western Oil Reporter, June, 1980; Keith, 1979: Index maps in GRA File).

5. Oil and Gas Economics

The low level of production from Nevada Basin and Range oil fields, which are remote from existing pipelines, existing refineries and consuming areas, necessitates the trucking of the crude oil to existing refineries in Utah, California and Nevada. Since the discovery of oil in Nevada in 1953, the level of production has fluxuated. Factors which have affected the production from individual wells are: reservoir and oil characteristics; Federal regulations; productivity; environmental constraints; willingness or ability of a refiner to take certain types

of oil; and of course, the price to the producer, which is tied to regional national and international prices.

Geothermal Resources

1. Known Geothermal Deposits

There are no known geothermal deposits in the GRA.

2. Known Prospects, Geothermal Occurrences, and Geothermal Areas

There are no known prospects, occurrences or thermal areas in the GRA, except for Virgin River Narrows Springs with temperatures of 75°-80°F (Locality #1 on the Geothermal Occurrences and Land Classification Map), which discharge at 270 gpm or more. West of the GRA, across Lake Mead, is Rogers Spring and Blue Point Spring (#2) with 81° to 86°F temperatures (Garside and Schilling, 1979).

3. Geothermal Leases

There are no Federal geothermal leases in the GRA.

4. Geothermal Deposit Types

Geothermal resources are hot water and/or steam which occurs in subsurface reservoirs or at the surface as springs. The temperature of a resource may be about 70°F (or just above average ambient air temperature) to well above 400°F in the Basin and Range province.

The reservoirs may be individual faults, intricate fault-fracture systems, or rock units having intergranular permeability -- or a combination of these. Deep-seated normal faults are believed to be the main conduits for the thermal waters rising from thousands of feet below in the earth's crust.

The higher temperature and larger capacity resources in the Basin and Range are generally hydrothermal convective systems. The lower temperature reservoirs may be individual faults bearing thermal water or lowr pressured, permeable rock units fed by faults or fault systems. Reservoirs are present from the surface to over 10,000 feet in depth.

5. Geothermal Economics

Geothermal resources are utilized in the form of hot water or steam normally captured by means of drilling wells to a depth of a few feet to over 10,000 feet in depth. The fluid temperature, sustained flow rate and water chemistry characteristics of a geothermal reservoir determine the depth to which it will be economically feasible to drill and develop each site.

Higher temperature resources (above 350°F) are currently being used to generate electrical power in Utah and California, and in a number of foreign countries. As fuel costs rise and technology improves, the lower temperature limit for power will decrease appreciably -- especially for remote sites.

All thermal waters can be beneficially used in some way, including fish farming (68°F), warm water for year around mining in cold climates (86°F), residential space heating (122°F), greenhouses by space heating (176°F), drying of vegetables (212°F), extraction of salts by evaporation and crystallization (266°F), and drying of diatomaceous earth (338°F).

Unlike most mineral commodities remoteness of resource location is not a drawback. Domestic and commercial use of natural thermal springs and shallow wells in the Basin and Range province is a historical fact for over 100 years.

Development and maintenance of a resource for beneficial use may mean no dollars or hundreds of millions of dollars, depending on the resource characteristics, the end use and the intensity or level of use.

D. OTHER GEOLOGICAL RESOURCES

No other geological reosources are known. There is no known potential for coal, tar sand or oil shale deposits in the GRA.

E. STRATEGIC AND CRITICAL MINERALS AND METALS

A list of strategic and critical minerals and metals provided by the BLM was used as a guideline for the discussion of strategic and critical materials in this report.

The Stockpile Report to the Congress, October 1981-March 1982, states that the term "strategic and critical materials" refers to materials that would be needed to supply the industrial, military and essential civilian needs of the United States during a national emergency and are not found or produced in the United States in sufficient quantities to meet such need.

The report does not define a distinction between strategic and critical minerals.

Quartz crystals of optical quality, a strategic mineral, occur in the GRA, but no production has been recorded (Longwell and others, 1965).

Small quantities of sheet mica, a strategic and critical mineral, have been produced in the GRA. According to Longwell and others, (1965) the size and quality of the mica that is known are not large.

Beryllium, a strategic metal, has been reported in small occurrences in the GRA.

IV. LAND CLASSIFICATION FOR G-E-M RESOURCES

Volborth (1962) provides fairly detailed geological mapping of much of the southern part of the GRA, and Longwell and others (1965) provide rather generalized mapping of the remainder at a scale of 1:250,000. Information on mineral occurrences is very limited and largely confined to mention of the commodities present and the amount of production. Overall, the quantity of geological data available is only moderate, and the quality is fair. The quantity of data available about mineral occurrences is low, and the quality is low. The level of confidence in the data available is moderate.

Land classification areas are numbered starting with the number 1 in each category of resources. Metallic mineral land classification areas have the prefix M, e.g., M1-4d. Uranium and thorium areas have the prefix U. Nonmetallic mineral areas have the prefix N. Oil and gas areas have the prefix OG. Geothermal areas have the prefix G. Sodium and potassium areas have the prefix S. The saleable resources are classified under the nonmetallic mineral resource section. Both the Classification Scheme, numbers 1 through 4, and the Level of Confidence Scheme, letters A, B, C, and D, as supplied by the BLM are included as attachments to this report. These schemes were used as strict guidelines in developing the mineral classification areas used in this report.

Land classifications have been made here only for the areas that encompass segments of the WSA. Where data outside a WSA has been used in establishing a classification area within a WSA, then at least a part of the surrounding area may also be included for clarification. The classified areas are shown on the 1:250,000 mylars or the prints of those that accompany each copy of this report.

In connection with nonmetallic mineral classification, it should be noted that in all instances areas mapped as alluvium are classified as having moderate favorability for sand and gravel. All areas mapped as principally limestone or dolomite have a similar classification since these rocks are usable for cement or lime production. All areas mapped as other rock, if they do not have specific reason for a different classification, are classified as having low favorability, with low confidence, for nonmetallic mineral potential, since any mineral material can at least be used in construction applications.

1. LOCATABLE RESOURCES

a. Metallic Minerals

WSA NV 050-0231

M1-1B. This classification area covers all of the WSA. No potential for metallic minerals is known in the area, which is the reason for the classification. The geology -- structurally simple sedimentary beds with no intrusive bodies -- is not very conducive to metallic mineral deposition, which is the reason for the low level of confidence.

WSA NV 050-0233

M2-3B. This classification area covers a small part of the WSA along the western boundary in the vicinity of the Azure Ridge mine. The mine itself may or may not be within the WSA, but the few claims in the WSA and south of the mine suggest there is at least weak mineralization. These are the reasons for the classification and the low level of confidence in it.

M3-1B. This classification area covers the remainder of the WSA. The rationale behind the classification and low level of confidence is the same as for M1-1B.

WSA NV 050-0235

M4-1A. This classification area covers all of the WSA as well as all of WSA NV 050-0238. No mines or prospects are known in the area, nor are there any unpatented claims except those inferred to be for uranium in WSA NV 050-0238. This is the reason for the classification of very low favorability. Nothing else is known, which is the reason for the lack of confidence in the classification.

WSA NV 050-0236

M5-1A. This classification area covers all of the WSA. The rationale for it is the same as that for M4-1A.

WSA NV 050-0238

M4-1A. This classification area covers all of the WSA, as well as all of WSA NV 050-0235. The rationale for the classification and confidence level is presented above under the latter WSA.

b. Uranium and Thorium

WSAs NV 050-0231, 050-0233, 050-0235, 050-0236, and 050-0238

U1-3C. This land classification area covers all of WSA NV 050-0238 and WSA NV 050-0236, the south half of WSA NV 050-0233, the eastern half of WSA NV 050-0235, and nearly all of WSA NV 050-0231. The area is moderately favorable for small uranium and thorium deposits, at a moderate level of confidence.

There are numerous uranium occurrences in sands and clays of the Tertiary Horse Springs Formation, and both uranium and thorium minerals are found in Precambrian pegmatites within the GRA. However, the deposits are small, and there has only been minor uranium production from two of the deposits, and none of the known occurrences are within the WSAs. The Horse Spring Formation apparently does not crop out within the WSAs except for a small area by the west central border of WSA NV 050-0231. The Precambrian granite and gneiss which contain the pegmatites do crop out or underlie much of this area within the WSAs. The Triassic Chinle Formation which crops out in the northern half of WSA NV 050-0231 is also a prospective uranium host. There is one known uranium occurrence in the Chinle Formation in the central portion of the GRA and there are numerous large and small uranium deposits in the Chinle Formation in the Colorado Plateau Province.

WSAs NV 050-0231, 050-0233 and 050-0235

U2-2B. This land classification includes the area of the WSAs covered by Quaternary alluvium and the Tertiary Muddy Creek Formation. The area has low favorability for uranium and thorium concentration, at a low level of confidence.

The Muddy Creek Formation unconformably overlies the Horse Creek Formation and is composed of similar fluvio-lacustrine sediments (i.e., sand, clay, and tuffs). The Muddy Creek Formation contains numerous small uranium occurrences in Mohave County, Arizona, though none are known within the GRA or the WSAs. The interbedded tuffs are the probable source of the uranium, as in the Horse Spring Formation uranium deposits. Both the Quaternary alluvium and the Tertiary Muddy Creek Formation are potential hosts for epigenetic sandstone-type uranium deposits. The tuffs of the Tertiary Muddy Creek and Horse Spring Formations and the Precambrian radioactive pegmatites of the adjacent mountains are possible source rocks for uranium.

Both thorium and uranium could occur as resistate mineral

concentrations in sands of the Quaternary and Tertiary sediments. Thorium and uranium minerals could have weathered out of the pegmatites in the mountains and been deposited by mechanical processes along with the alluvial fans. However, it is not certain if sufficient reworking of the sediments needed to concentrate these heavy minerals took place during deposition.

c. Nonmetallic Minerals

WSA NV 050-0231

N1-3D. This classification area covers much of the WSA. It is the area in which Paleozoic beds crop out, some of which are suitable for production of lime. No mines or prospects are known, but patented claims may have been located for the lime. The presence of the beds and their known suitability for lime production is the reason for the classification and the high level of confidence in it.

N2-3B. This classification area covers a small part of the north end of the WSA. It is the outcrop area of the Triassic Moenkopi Formation, which contains gypsum beds that are mined elsewhere in the region; this is the reason for the moderately favorable classification. Whether the gypsum beds are present within the WSA is not known, which is the reason for the low level of confidence.

N3-2B. This classification area covers a rather small part of the south end of the WSA. It is the outcrop area of Precambrian rocks, in which no nonmetallic mineral occurrences are known in the WSA. However, essentially any mineral material can be used for construction applications, whichis the reason for the classification of low favorability with low confidence.

N4-3C. This classification area covers the southwestern part of the WSA and narrow strips along the northern part of the west edge of the WSA. It is mapped as Quaternary alluvium, which by definition contains sand and gravel. This is the reason for the classification assigned. The level of confidence is only moderate because the quality of the sand and gravel deposits at any given place is unknown.

WSA NV 050-0233

N5-3D. This classification area covers most of the WSA. It is the area of outcrop of Paleozoic rocks, and the rationale for the classification and level of confidence is the same as for N1-3D.

N6-3C. This classification area covers the northern part of the WSA and part of the eastern edge. It is mapped as Quaternary alluvium, and the rationale for the classification and the level of confidence is the same as for N4-3C.

WSA NV 050-0235

N4-3C. This classification area covers the western and northwestern parts of the WSA. It is the area of Quaternary alluvium, and the rationale for the classification and the level of confidence are presented under WSA NV 050-0231.

N9-2B. This classification area covers the remainder of the WSA. It is the area of Precambrian schist and intrusive outcrops, and the rationale for the classification and the level of confidence is the same as for N3-1A.

WSA NV 050-0236

N7-3C. This classification area covers a small part of the western edge of the WSA. It is part of the area in which Beal (1963) found titaniferous pegmatites and gravels containing titanium minerals, although uncertainty about the exact position of the WSA boundary makes it questionable whether any of his samples came from within the WSA boundary. The presence of titanium is the reason for the moderately favorable classification, while the uncertainty about the sample sites and WSA boundary locations are the reason for the only moderate level of confidence.

N9-2B. This classification area covers the remainder of the WSA. Precambrian schists and intrusive rocks crop out in it, and the rationale for the classification and the level of confidence are the same as for N3-2B.

WSA NV 050-0238

N8-3C. This classification are covers a strip along the northeastern edge of the WSA. It is an area in which Beal (1963) found titanium, and the rationale for the classification is the same as for N7-3C.

N9-2B. This classification area covers most of the WSA. It is the outcrop area of Precambrian schists and intrusives. The rationale for the classification and the level of confidence is the same as for N3-2B.

2. LEASABLE RESOURCES

a. Oil and Gas

WSAs Nv 050-0231, NV 050-0233, NV 050-0235, NV 050-0236 and NV 050-0238

OG1-2A. This group of WSAs is located in the Overthrust Belt which is being actively explored from Canada to Mexico. Although WSAs 050-0236 and 050-023 are underlain by Precambrian rocks, should thrusting be present, there is a possibility that favorable conditions for the accumulation of hydrocarbons may exist under the WSAs. The same conditions exist for each of the other WSAs, but segments of the other WSAs also have potential for oil and gas in non-thrusted sections. Companies have leased many square miles in each of the WSAs -- even those underlain by Precambrian rocks. Although the favorability of segments of each WSA varies, they all range in the 2A classification.

b. Geothermal

WSA NV 050-0235, NV 050-0236, and NV 050-0238

G1-1A. These portions of the WSAs are underlain by a Precambrian mass which has not been faulted extensively as many areas in the Basin and Range province. Without the normal faulting to act as thermal water conduits, the favorability is very low with low confidence.

WSA NV 050-0231, NV 050-0233, and NV 050-0235

G2-2A. This classification incorporates those portions of the WSAs which are highly faulted (or potentially so beneath the Quaternary alluvium). The WSAs are within a large region of low-temperature geothermal resources. Faulting of Late Cenozoic age is common to many or all of the mountain ranges and valleys in Nevada, and is genetically related to the geothermal sites.

c. Sodium and Potassium

S1-1A. There is no known potential for sodium and potassium in the WSA. According to Longwell and others (1965), salt was produced from mines in the Muddy Creek Formation that are now covered by Lake Mead. The Muddy Creek Formation is known to be present in the GRA. However, again according to Longwell and others (1965), in 1942 while Lake Mead was being formed, intensive studies were made to determine if there were sites above the final lake level where there might be salt deposits in the Muddy

Creek Formation. The conclusion was that the only likely sites were at places well west of the GRA. This is the reason for the very low favorability classification, and the very low level of confidence in this classification. No map is presented for sodium and potassium.

3. SALEABLE RESOURCES

Saleable resources have been covered in the section on Nonmetallic Minerals

V. RECOMMENDATIONS FOR ADDITIONAL WORK

1. BLM records pertaining to the patented claims in WSA NV 050-0231 should be examined. If there are as many patented claims as has been inferred here, the area of the claims may not be eligible for Wilderness.

2. BLM records pertaining to the unpatented claims in WSAs NV 050-0233 and 050-0238 should be examined to determine the number of claims in these groups. If there are fairly numerous claims, the areas should be examined on the ground to see if there are altered areas that might indicate extensive mineralization. The reports and geologic maps available were all made before current concepts of alteration -- and mapping of alteration -- were in use.

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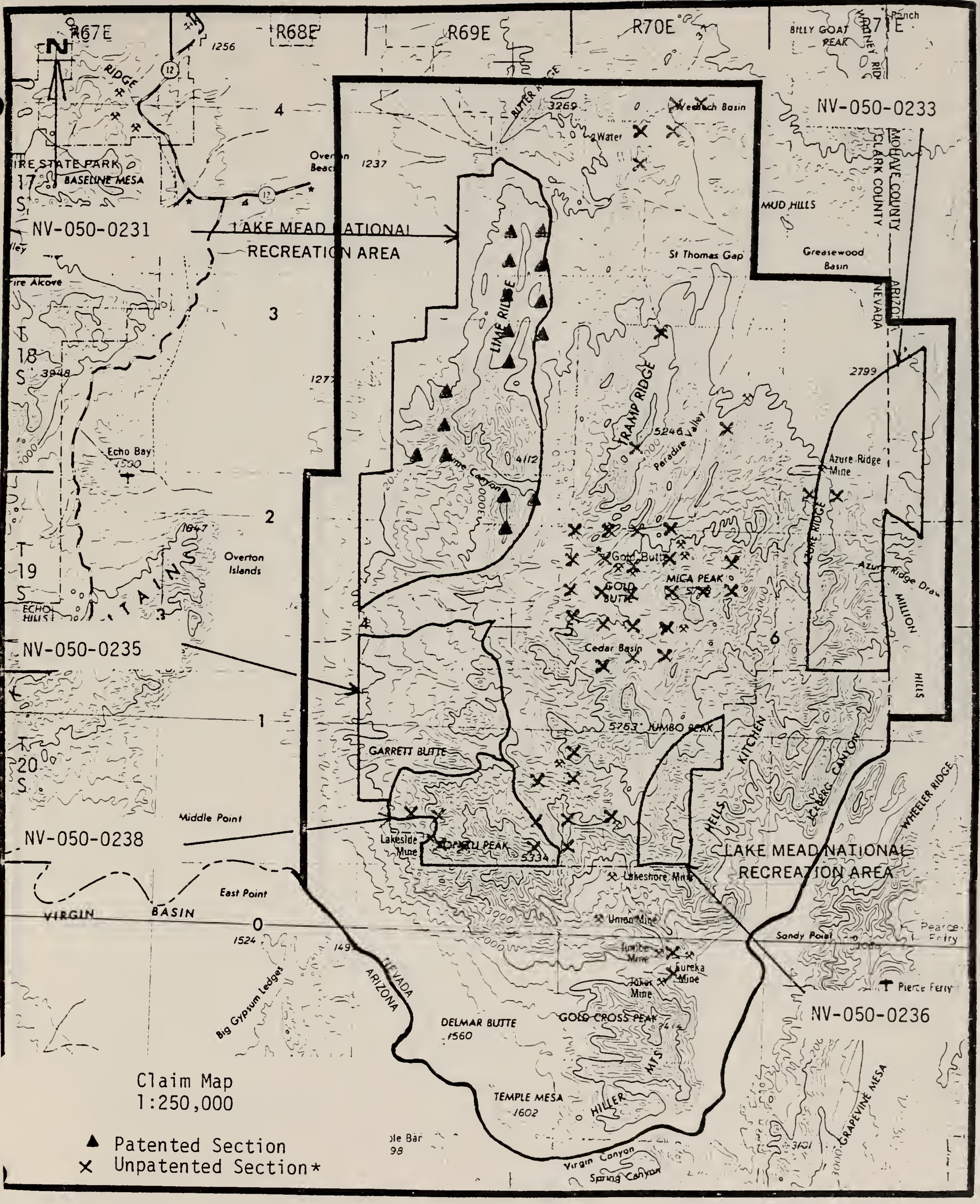
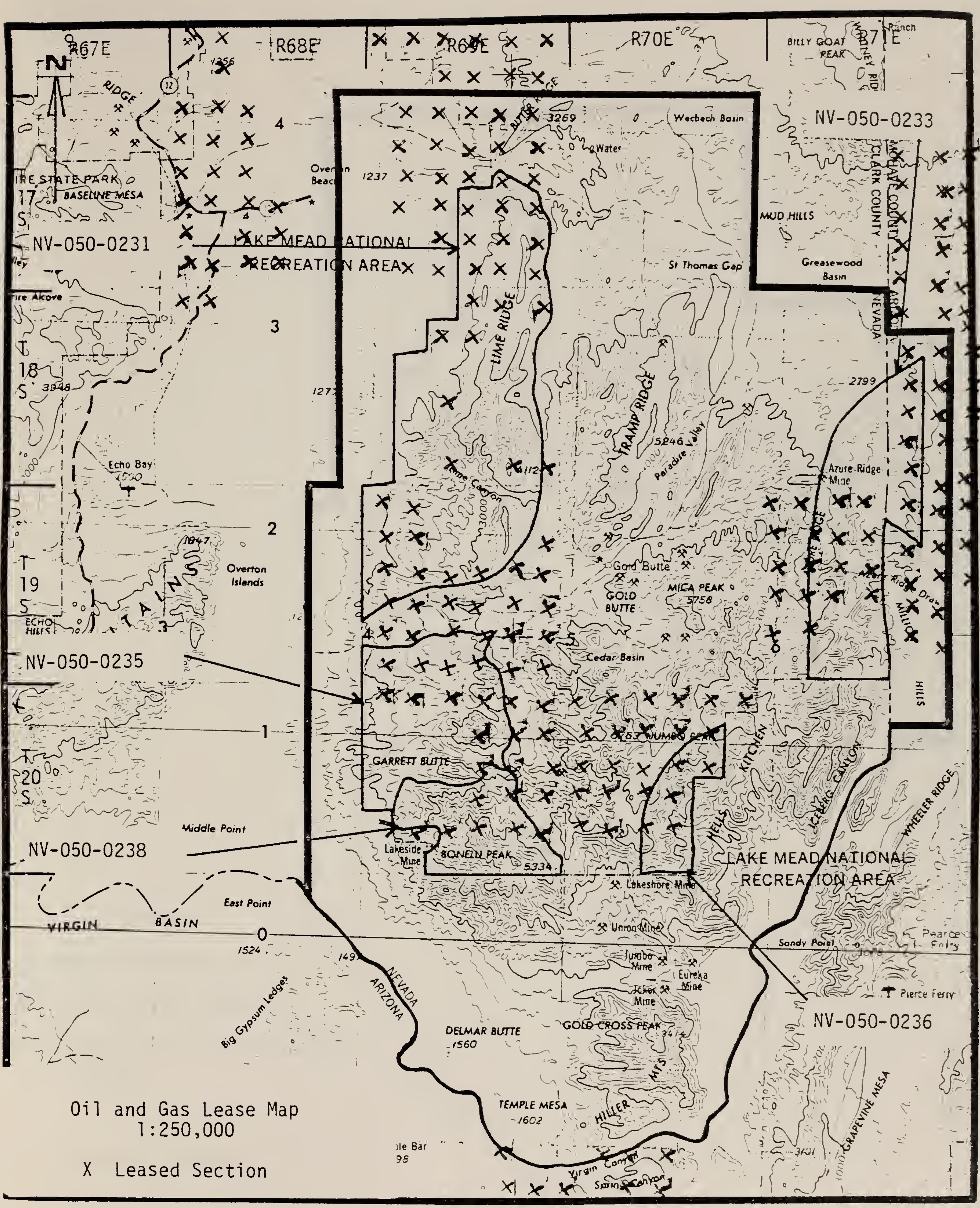


Claim Map
1:250,000

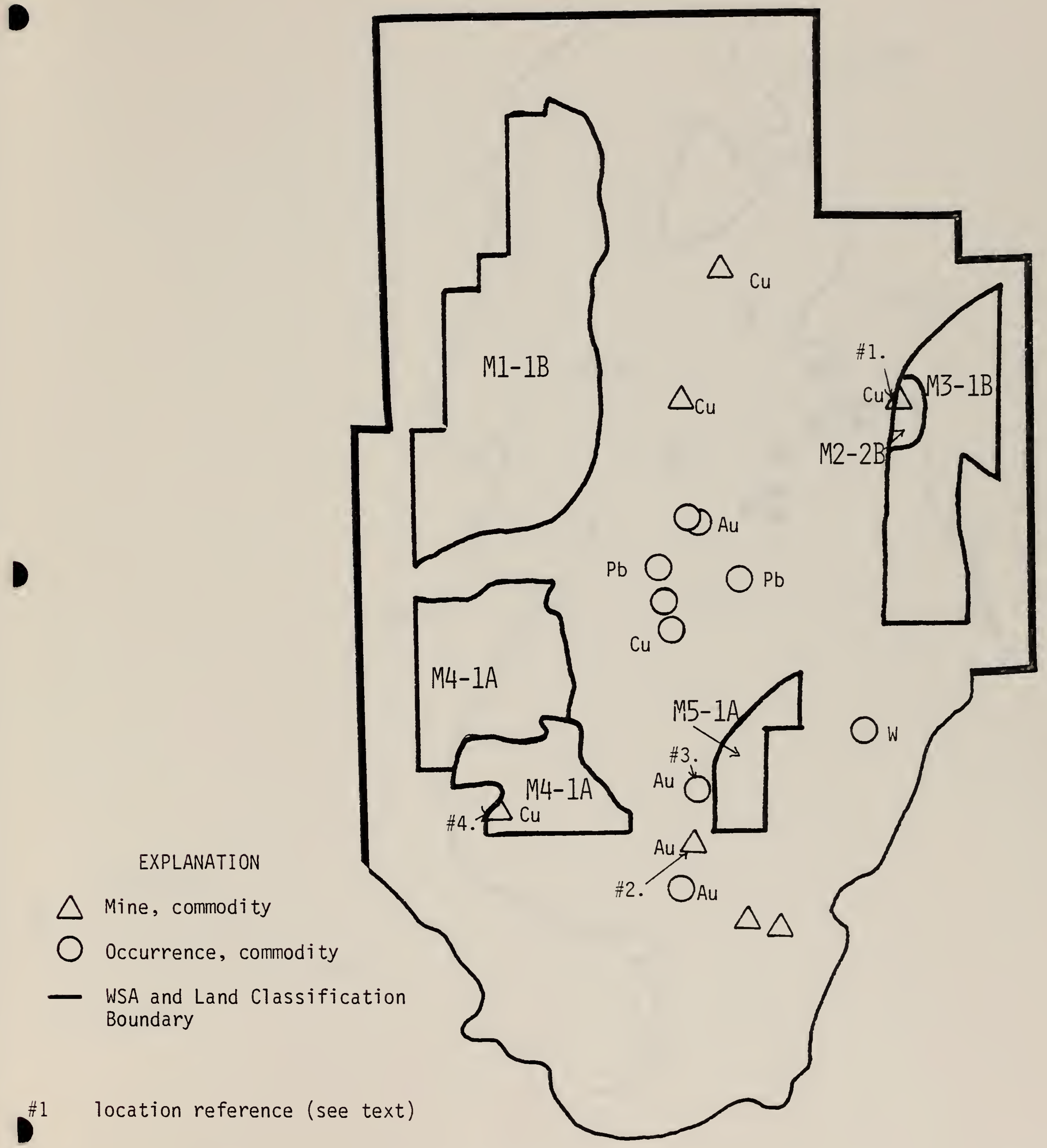
▲ Patented Section
✕ Unpatented Section*

*X denote one or more claims per section



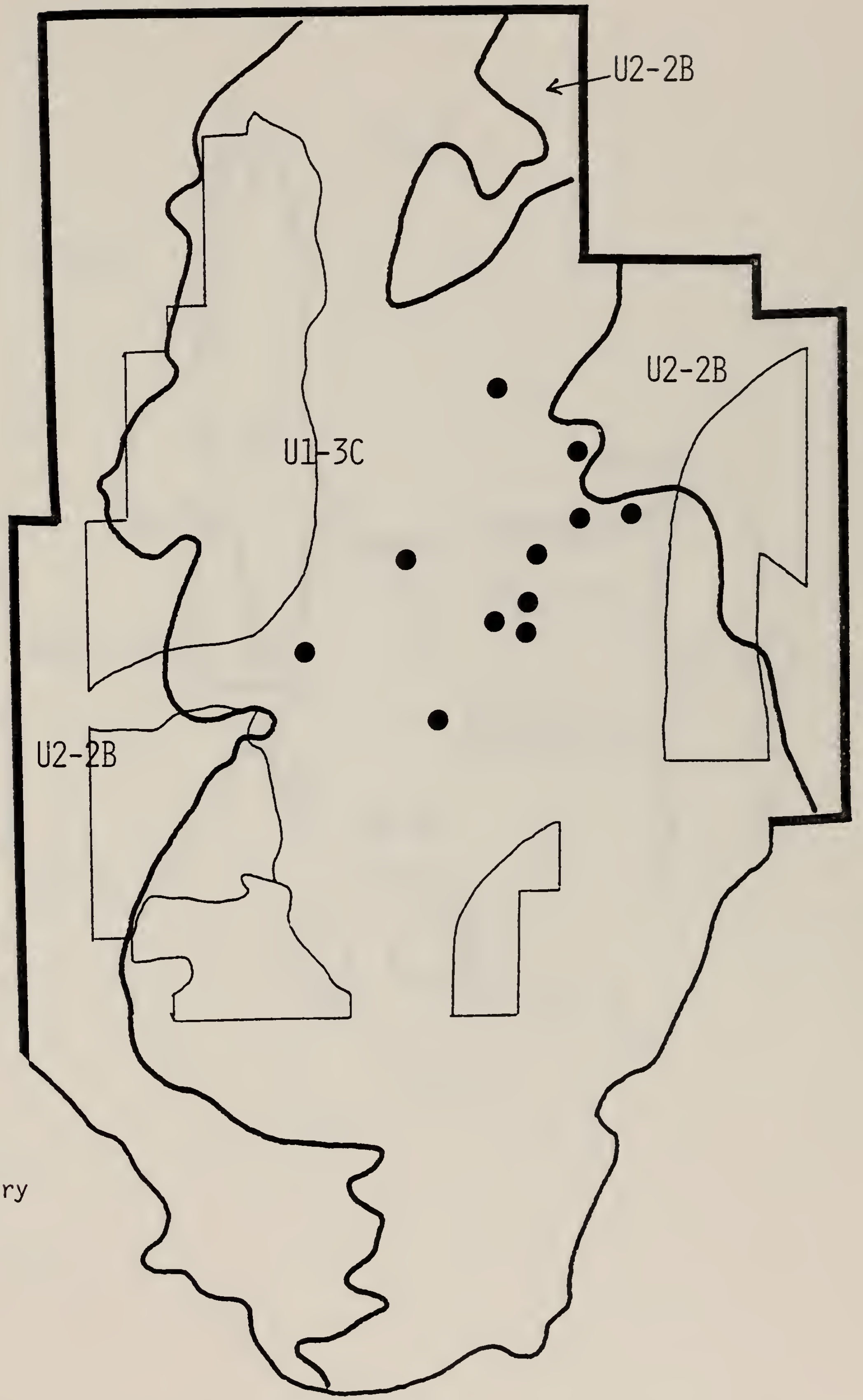
Oil and Gas Lease Map
1:250,000

X Leased Section



Land Classification - Mineral Occurrence Map/Metallics

Lake Mead GRA NV-35
Scale 1:250,000



EXPLANATION

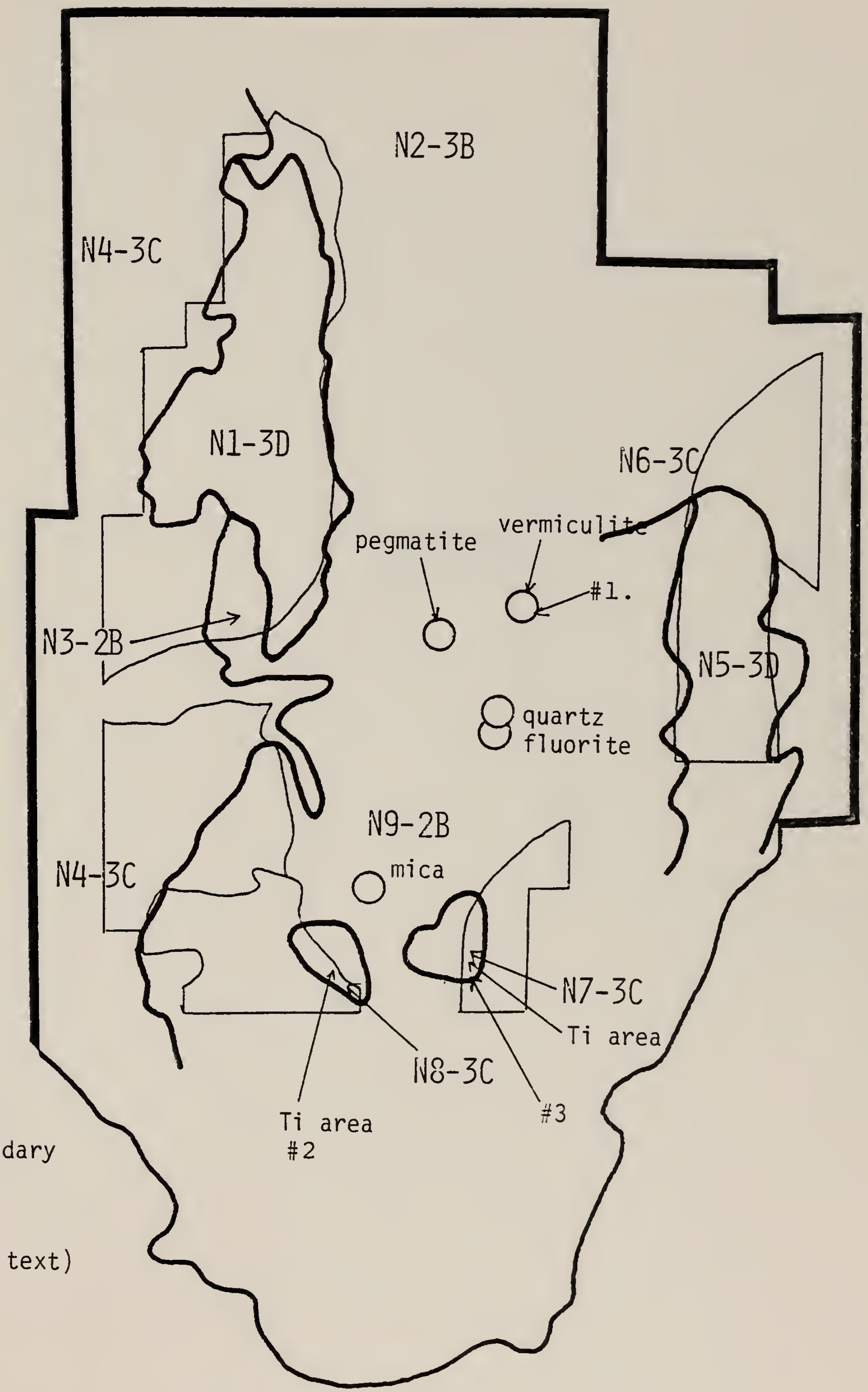
● Uranium Occurrence

━ Land Classification Boundary

— WSA Boundary

Land Classification - Mineral Occurrence Map/Uranium

Lake Mead GRA NV-35
Scale 1:250,000



EXPLANATION

○ Occurrence, commodity

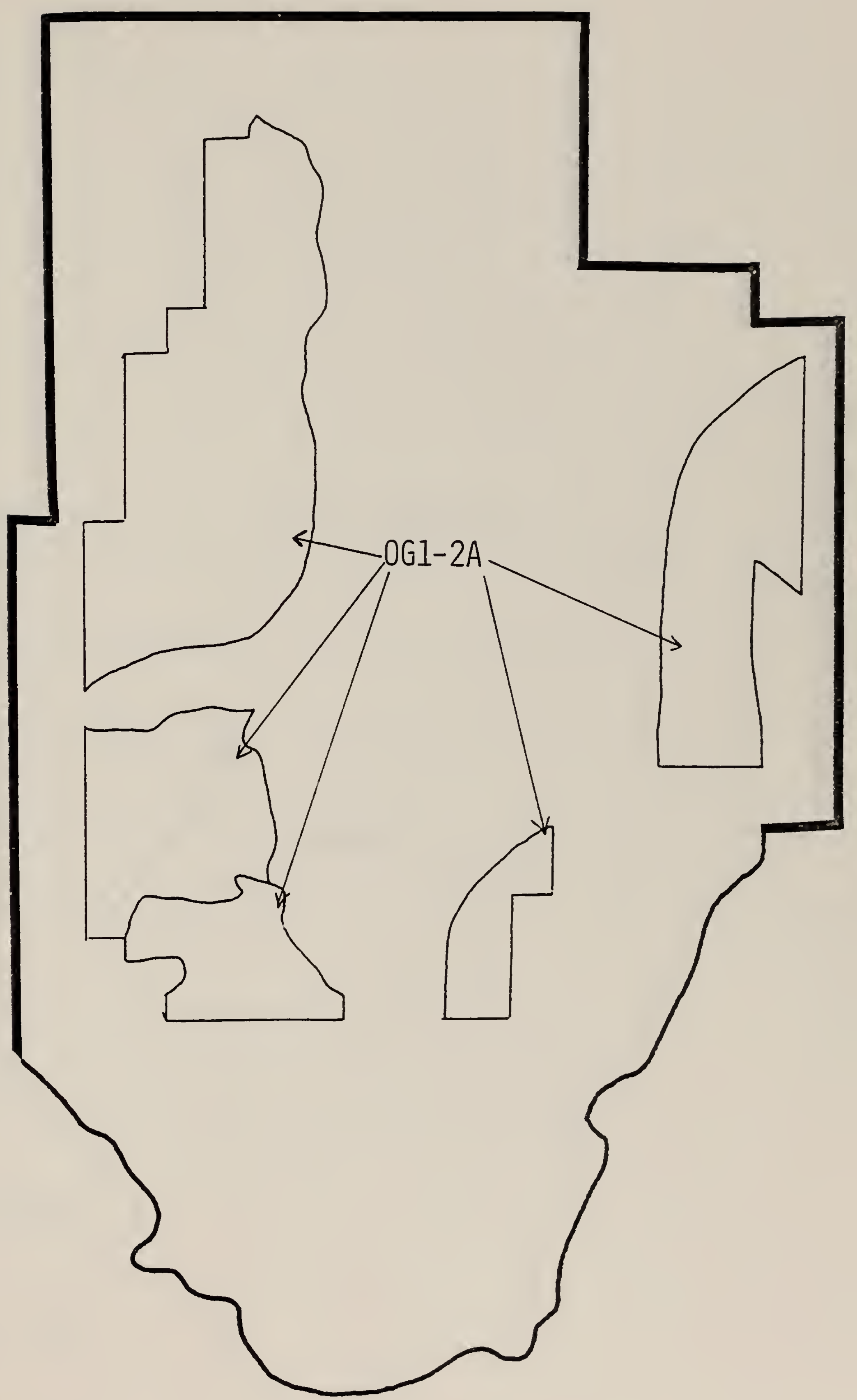
▬ Land Classification Boundary

— WSA Boundary

#1. location reference (see text)

Land Classification - Mineral Occurrence Map/Nonmetallics

Lake Mead GRA NV-35
Scale 1:250,000

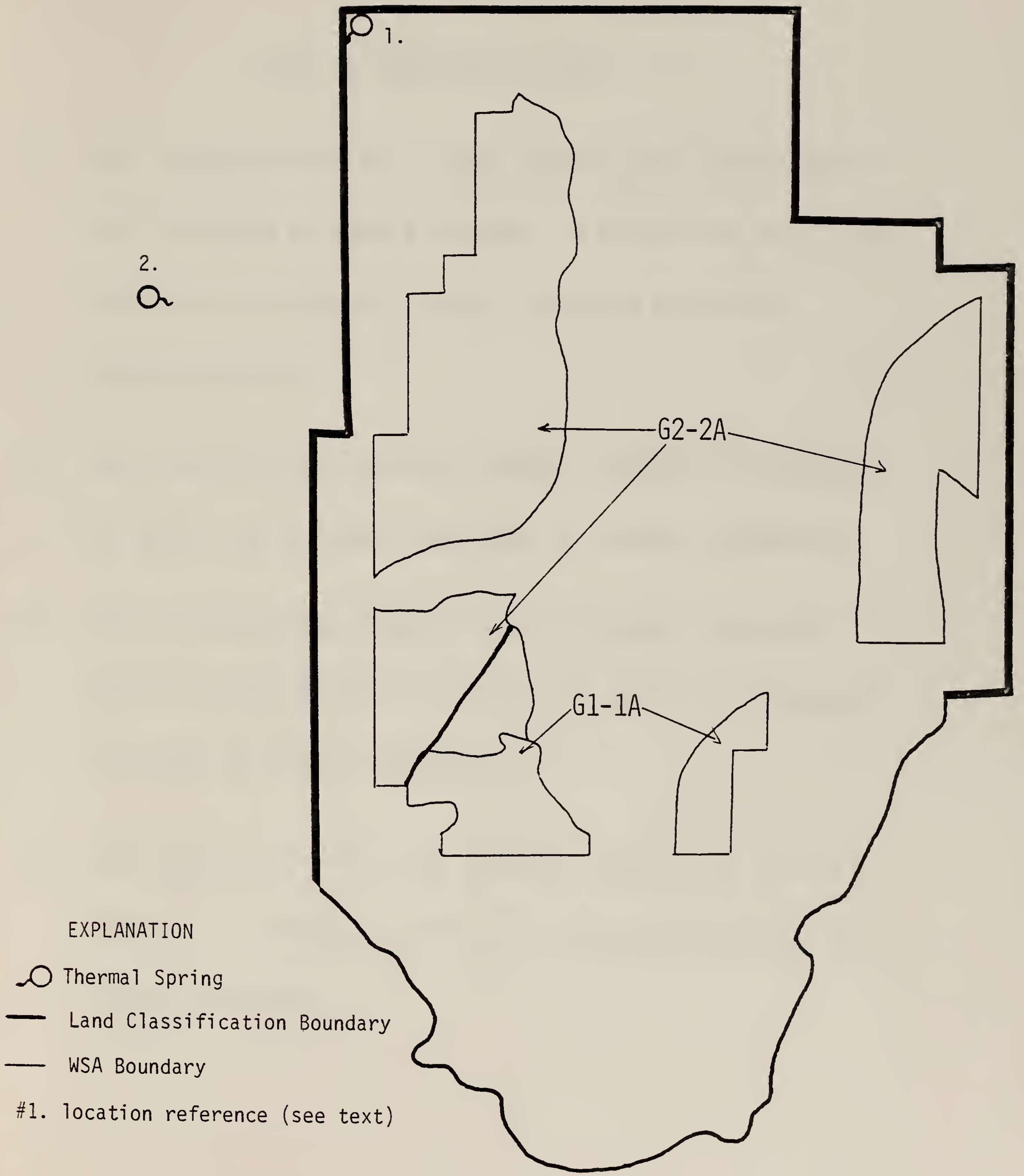


EXPLANATION

— WSA and Land Classification Boundary

Land Classification - Mineral Occurrence Map/Oil & Gas

Lake Mead GRA NV-35
Scale 1:250,000


1.
2.
G2-2A
G1-1A
EXPLANATION
Thermal Spring
Land Classification Boundary
WSA Boundary
#1. location reference (see text)

Lake Mead GRA NV-35
Scale 1:250,000

Land Classification - Mineral Occurrence Map/Geothermal

LEVEL OF CONFIDENCE SCHEME

A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVELY MINIMAL TO SUPPORT TO REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

MAJOR STRATIGRAPHIC AND TIME DIVISIONS IN USE BY THE U.S. GEOLOGICAL SURVEY

Erathem or Era		System or Period	Series or Epoch	Estimated ages of time boundaries in millions of years
Cenozoic		Quaternary	Holocene	
			Pleistocene	2-3 [1]
		Tertiary	Pliocene	12 [1]
			Miocene	26 [2]
			Oligocene	37-38
			Eocene	53-54
			Paleocene	65
Mesozoic		Cretaceous [4]	Upper (Late) Lower (Early)	136
		Jurassic	Upper (Late) Middle (Middle) Lower (Early)	190-195
		Triassic	Upper (Late) Middle (Middle) Lower (Early)	225
Paleozoic		Permian [4]	Upper (Late) Lower (Early)	280
	Carboniferous Systems	Pennsylvanian [4]	Upper (Late) Middle (Middle) Lower (Early)	
		Mississippian [4]	Upper (Late) Lower (Early)	345
		Devonian	Upper (Late) Middle (Middle) Lower (Early)	395
		Silurian [4]	Upper (Late) Middle (Middle) Lower (Early)	430-440
		Ordovician [4]	Upper (Late) Middle (Middle) Lower (Early)	500
		Cambrian [4]	Upper (Late) Middle (Middle) Lower (Early)	570
Precambrian [4]			Informal subdivisions such as upper, middle, and lower, or upper and lower, or younger and older may be used locally.	3,600+ [3]

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[1] Holmes, Arthur, 1965, Principles of physical geology: 2d ed., New York, Ronald Press, p. 360-361, for the Pleistocene and Pliocene; and Obradovich, J. D., 1965, Age of marine Pleistocene of California: Am. Assoc. Petroleum Geologists, v. 49, no. 7, p. 1087, for the Pleistocene of southern California.

[2] Geological Society of London, 1964, The Phanerozoic time-scale; a symposium: Geol. Soc. London, Quart. Jour., v. 120, supp., p. 260-262, for the Miocene through the Cambrian.

[3] Stern, T. W., written commun., 1968, for the Precambrian.

[4] Includes provincial series accepted for use in U.S. Geological Survey reports.

Terms designating time are in parentheses. Informal time terms early, middle, and late may be used for the eras, and for periods where there is no formal subdivision into Early, Middle, and Late, and for epochs. Informal rock terms lower, middle, and upper may be used where there is no formal subdivision of a system or of a series.

GEOLOGIC NAMES COMMITTEE, 1970